State Facilities on Oahu Benchmarking Study and Oak Ridge National Laboratory Technical Review

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November 3, 2005

STATE OF HAWAII FACILITIES ON OAHU BENCHMARKING STUDY

Submitted to:
The State of Hawaii
Department of Business, Economic Development, & Tourism
Strategic Industries Division

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State Facilities On Oahu Energy Benchmarking Study

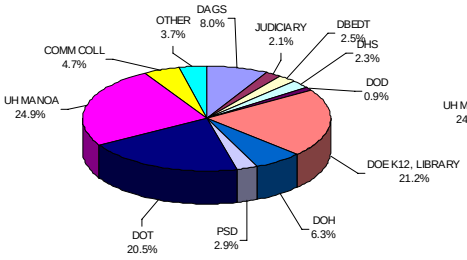
- Develop a database to compare energy use of all State of Hawaii Facilities on Oahu.
- Build upon existing data:
  - Metered data from HECO Electricity Meters
  - HECO Rebate History from 1997 to 2004
  - Existing Energy Audits Reports
  - Previously Conducted "State Facility Energy Upgrade Analysis and Performance Contracting Potential Phase II Report"
  - Existing UH Manoa Campus Benchmarking Report
  - SODAGS State facilities Square Footage Building Area Estimate 2001 for certain State Departments
- Extrapolate estimates for buildings where no data exists.
- Allow ranking by multiple parameters:
  - State Department
  - Building Occupancy Type
  - Energy Utilization Index (EUI)
  - Energy Saving Potential
- Estimate energy savings and costs.

State Facilities On Oahu Energy Benchmarking Study

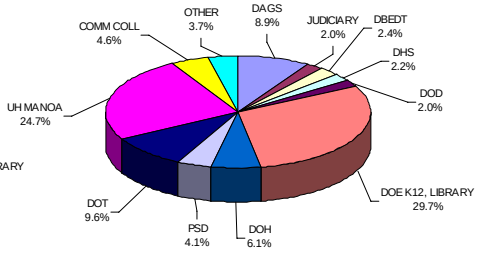
Current conditions:

1) 26,367,927 sf. occupancy building space
2) 557,654,688 kWh/year electricity consumption in 2004
3) $71,372,318 electricity cost
4) 21.1 kWh/sf yearly electricity use
5) $2.70/sf. electricity cost

STATE OF HAWAII FACILITIES ON OAHU ELECTRICITY CONSUMPTION BY STATE AGENCY



STATE OF HAWAII FACILITIES ON OAHU BUILDING AREA BY STATE AGENCY

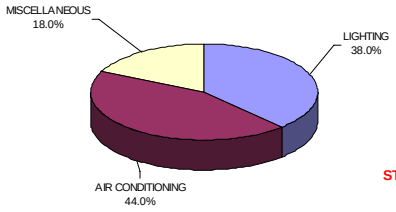


Ratio of % Energy Use per % Building Area	Ratio
DAGS	0.9
JUDICIARY	1.1
DBEDT	1.1
DOD	0.5
DOE K12, PUBLIC LIBRARY	0.7
DOH	1.0
PSD	0.7
DOT	2.1
UH MANOA	1.0
COMM COLL	1.0
DHS	1.1
OTHER	1.0

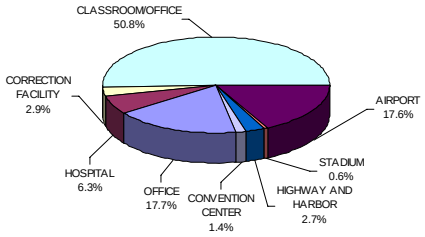
Energy Use per kW/year/sf. by State Agency

State Agency	Total Occupied Building Space (sq.ft.)	% Total Building Space (sq.ft.)	Total Building Electricity (kWh/year)	Total Building Electricity Use per square foot (kWh/sq.ft.-year)	% of Total Energy Use	% Energy Use per % Building Area
UH MANOA	6,509,109	24.7	138,877,571	21.3	24.9	1.0
DOE K12, PUBLIC LIBRARY	7,829,650	29.7	118,266,875	15.1	21.2	0.7
DOT	2,540,917	9.6	114,437,730	45.0	20.5	2.1
DAGS	2,337,265	8.9	44,505,800	19.0	8.0	0.9
DOH	1,606,870	6.1	35,116,171	21.9	6.3	1.0
COMM COLL	1,220,733	4.6	26,045,410	21.3	4.7	1.0
PSD	1,087,733	4.1	16,316,000	15.0	2.9	0.7
OTHER	971,907	3.7	20,530,537	21.1	3.7	1.0
DBEDT	620,043	2.4	13,805,340	22.3	2.5	1.1
DHS	578,056	2.2	12,870,502	22.3	2.3	1.1
JUDICIARY	536,839	2.0	11,952,797	22.3	2.1	1.1
DOD	528,803	2.0	4,929,956	9.3	0.9	0.5
TOTAL	26,367,927	100	557,654,688	21.1	100	

STATE OF HAWAII FACILITIES IN OAHU ELECTRICITY USE BY UTILITY TYPE

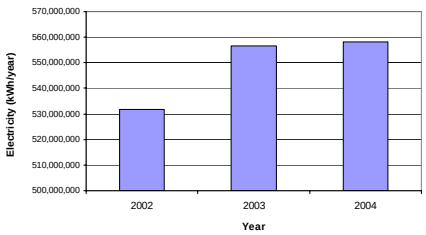


STATE OF HAWAII FACILITIES IN OAHU ELECTRICITY CONSUMPTION BY OCCUPANCY TYPE

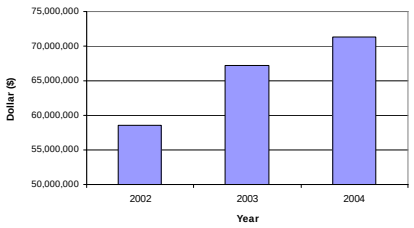


State Facilities on Oahu Electricity Consumption and Spending Trend for the Past Three Years

State Facilities on Oahu Total Yearly Electricity Consumption



State Facilities on Oahu Total Yearly Spending for Electricity



YEAR	Electricity Consumption per Year	Electricity Cost per Year
2002	531,823,960	$58,540,841
2003	556,768,580	$67,245,821
2004	557,654,688	$71,372,318

State Facilities On Oahu Energy Use Spreadsheet Analysis

STATE OF HAWAII FACILITIES ON OAHU ENERGY BENCHMARK ANALYSIS

Building Name	Building Type	Operation Schedule hour	Year-Built	Area (sq.ft.)	Energy Use kWh/year	kWh/sq.ft.-year	$/year	$/sq.ft.-year
DAGS								
LARGE FACILITIES								
415 SOUTH BERETANIA (STATE CAPITOL)	Office	10	1969	300,000	6,126,000	20.4	790,618	2.6
919 ALA MOANA BLVD (AAFES)	Office	10		108,000	2,243,000	20.8	297,353	2.8
1390 MILLER ST (QUEEN LILIOLULANI)	Office	11.5	1943	94,528	2,534,000	26.8	333,361	3.5
1151 PUNCHBOWL ST (KALANIMOKU)	Office	10	1976	203,000	7,037,400	34.7	877,507	4.3
1250 PUNCHBOWL ST (KINAU HALE)	Office	11	1961	66,951	1,631,200	24.4	222,814	3.3
250 S HOTEL ST (NO. 1-DISTRICT BLDG)	Office	10		120,000	2,567,040	21.4	321,188	2.7
465 S KING ST (KEKUANAO'A BLDG)	Office	11		65,075	1,471,760	22.6	196,359	3.0
235 S BERETANIA ST (OFFICE TOWER)	Office	10	1991	172,000	2,502,400	14.5	337,136	2.0
830 PUNCHBOWL ST (KEELIKOLANI & AUHAU)	Office	12	1949	278,639	4,174,800	15.0	558,214	2.0
601 KAMOKILA BV (KAKUIHEWA KAPOLEI)	Office	10	1998	222,000	3,050,400	13.7	408,107	1.8
99500 SALT LAKE BV (STADIUM AUTHORITY)	Stadium			300,000	3,416,400	11.4	532,406	1.8
Sub-TOTAL				**1,930,193**	**36,754,400**	**19.0**	**4,875,063**	**2.5**
MEDIUM AND SMALL FACILITIES								
Sub-TOTAL	Office			**407,072**	**7,751,397**	**19.0**	**1,129,000**	**2.5**
Sub-TOTAL								
TOTAL				**2,337,265**	**44,505,797**	**19.0**	**6,004,063**	**2.6**

State Facilities On Oahu Energy by End Use Spreadsheet Analysis

STATE OF HAWAII FACILITIES ON OAHU ENERGY BENCHMARK ANALYSIS BY END USE

Building Name	Building Type	Operation Schedule hour	Year-Built	Area (sq.ft.)	Energy Use Distribution by Utility: HVAC kWh/year	HVAC kWh/sq.ft.-year	LIGHTING kWh/year	LIGHTING kWh/sq.ft.-year	MISCELLANEOUS kWh/year	MISCELLANEOUS kWh/sq.ft.-year
DAGS										
LARGE FACILITIES										
415 SOUTH BERETANIA (STATE CAPITOL)	Office	10	1969	300,000	3,185,520	10.62	1,837,800	6.13	1,102,680	3.68
919 ALA MOANA BLVD (AAFES)	Office	10		108,000	1,166,360	10.80	672,900	6.23	403,740	3.74
1390 MILLER ST (QUEEN LILIOLULANI)	Office	11.5	1943	94,528	1,317,680	13.94	760,200	8.04	456,120	4.83
1151 PUNCHBOWL ST (KALANIMOKU)	Office	10	1976	203,000	3,659,448	18.03	2,111,220	10.40	1,266,732	6.24
1250 PUNCHBOWL ST (KINAU HALE)	Office	11	1961	66,951	848,224	12.67	489,360	7.31	293,616	4.39
250 S HOTEL ST (NO. 1-DISTRICT BLDG)	Office	10		120,000	1,334,861	11.12	770,112	6.42	462,067	3.85
465 S KING ST (KEKUANAO'A BLDG)	Office	11		65,075	765,315	11.76	441,528	6.78	264,917	4.07
235 S BERETANIA ST (OFFICE TOWER)	Office	10	1991	172,000	1,301,248	7.57	750,720	4.36	450,432	2.62
830 PUNCHBOWL ST (KEELIKOLANI & AUHAU)	Office	12	1949	278,639	2,170,896	7.79	1,252,440	4.49	751,464	2.70
601 KAMOKILA BV (KAKUIHEWA KAPOLEI)	Office	10	1998	222,000	1,586,208	7.15	915,120	4.12	549,072	2.47
99500 SALT LAKE BV (STADIUM AUTHORITY)	Stadium			300,000	1,776,528	5.92	1,024,920	3.42	614,952	2.05
Sub-TOTAL				**1,930,193**	**19,112,288**	**9.90**	**11,026,320**	**5.71**	**6,615,792**	**3.43**
MEDIUM AND SMALL FACILITIES										
Sub-TOTAL	Office			**407,072**	**4,030,726**	**9.90**	**2,325,419**	**5.71**	**1,395,251**	**3.43**
Sub-TOTAL										
TOTAL				**2,337,265**	**23,143,014**	**9.90**	**13,351,739**	**5.71**	**8,011,043**	**3.43**

Energy Conservation Measures Evaluated for the State of Hawaii Facilities on Oahu

ECM-I: Interior and Exterior Lighting Replacement
ECM-II: LED Exit Sign Installation
ECM-III: Reflective Solar Window Tinting
ECM-IV: Chiller Retrofits
ECM-V: Variable Speed Drive Utilization
ECM-VI: Motor Replacement with High Efficiency Motors
ECM-VII: Waste Heat Recovery System
ECM-VIII: Packaged Air Conditioning Unit Replacement
ECM-IX: Energy Management System (EMS) Installation
ECM-X: Building Envelope Insulation Installation
ECM-XI: OTHER (Constant Volume System to Variable Volume System Conversion, VAV Control Systems Repair, Outside Air CO2 Sensor Installation)

Energy Conservation Measures Recommended for the State Facilities on Oahu, Sorted by Potential Energy Savings

Description		Estimated Energy Savings (kWh/year)	Estimated Energy Savings %	Estimated Energy Cost Savings ($/year)	Estimated Construction Cost ($)	Simple Payback (year)
ECM-IV	Chiller Retrofits	20,590,260	3.7	2,630,636	35,157,100	13.4
ECM-I	Interior and Exterior Lighting Replacement	17,048,460	3.1	2,439,780	16,522,333	6.8
ECM-IX	Facility Management Systems (FMS) Installation	11,443,680	2.1	1,476,604	1,766,651	1.2
ECM-V	Variable Speed Drive Utilization	11,300.314	2.0	1,451,133	6,777,101	4.7
ECM-X	Insulation Installation	5,415,477	1.0	685,556	5,062,642	7.4
ECM-III	Reflective Solar Window Tinting	3,665,623	0.7	474,623	2,900,472	6.1
ECM-XI	Other	3,398,489	0.6	441,154	4,122,034	9.3
ECM-VI	Motor Replacement with High Efficiency Motors	2,396,361	0.4	301,764	2,094,597	6.9
ECM-II	LED Exit Sign Installation	1,450,236	0.3	553,726	2,241,274	4.0
ECM-VIII	Packaged Air Conditioning Unit Replacement	1,253,157	0.2	159,300	1,338,116	8.4
ECM-VII	Waste Heat Recovery System	944,912	0.2	121,538	273,887	2.3
	Totals	78,906,487	14.2	10,735,823	78,256,206	7.3

State Facilities on Oahu
ECM Savings Potential by State Agency

Building Occupancy	Estimated Energy Savings (kWh/year)	Estimated Energy Savings (kWh/sq. ft.-year)	Estimated Energy Savings %	Estimated Energy Cost Savings ($)	Estimated Energy Cost Savings Per sq. ft. ($)	Estimated Construction Cost ($)	Estimated Const. Cost per sq. ft. ($)	Simple Payback (Year)
UH MANOA	28,952,157	4.5	5.2	3,891,630	0.60	31,906,080	4.9	8.2
DOE K12, PUBLIC LIBRARY	11,895,402	1.5	2.1	1,690,408	0.22	8,751,558	1.1	5.2
DOT	9,389,534	3.7	1.7	1,247,371	0.50	10,320,922	4.1	8.3
DAGS	8,195,882	3.5	1.5	1,117,324	0.48	8,482,092	3.4	5.5
DOH	5,787,111	3.6	1.0	780,453	0.49	5,711,629	3.6	7.3
COMM COLL	3,779,793	3.1	0.7	501,856	0.41	4,107,137	3.4	8.2
OTHER*	2,742,918	2.8	0.5	379,141	0.39	2,015,736	2.1	5.3
PSD	2,213,972	2.0	0.4	314,355	0.29	1,761,040	1.6	5.6
DHS	2,218,352	3.8	0.4	300,422	0.52	2,182,610	3.9	7.4
DOD	1,745,860	3.3	0.3	238,626	0.45	1,521,358	2.9	6.4
DBEDT	1,153,667	1.9	0.2	160,331	0.26	823,276	1.3	5.1
JUDICIARY	831,839	1.6	0.2	113,905	0.21	672,767	1.3	5.9
TOTAL	78,906,487	3.0	14.2	10,735,823	0.41	78,256,206	3.0	7.3

* OTHER: Department of Attorney General
Department of Labor and Industrial Relations
Department of Land and Natural Resources
Department of Hawaiian Homelands
Department of Agriculture

U.S. Department of Energy Oak Ridge National Laboratory (ORNL) Review

- Conducted under ORNL's State Partnership Program that provides technical assistance to States
- Reviewer was Terry Sharp, Engineering Science & Technology Division
- Sharp also assisted us with the review of the Maui Schools Benchmarking Study

ORNL Review
Major Conclusions

- Report meets its objectives
  - Evaluates electrical energy use of State facilities on Oahu
  - Identifies viable energy conservation measures (ECM's)
  - Estimated energy savings of 78,906 MWH per year, approximately 14% of total electrical use, is a reasonable expectation for across-the-board savings
  - Identifies agencies that could pursue energy retrofits through ESPC

ORNL Review
Specific Observations

- Prioritizing retrofits
  - 30% of building area is in the Dept. of Education (DOE)
  - 25% of building area is at UH-Manoa
  - 108 of 2625 buildings are large and account for 75% of electricity use of all State facilities

ORNL Review
Specific Observations

- The number of assumptions and “estimates” of realistic numbers are substantial
- The results are not in error, but there is a confidence issue
- There is a significant risk that estimates vary from what actually exists
- But, reported numbers appear “in the range” of normal expectations

ORNL Review
Specific Observations

- Grouping by building type and then prioritizing buildings by energy use per square foot is a first cut option for prioritization
- Approach is not robust enough by itself to be consistently reliable
- Variations in occupancy, operating hours, etc. among buildings must be considered to achieve reliable prioritization

ORNL Review
Specific Observations

- Report indicates potential for installing “facilities management systems” with a projected 2.1% in total energy savings with simple payback of 1.2 years
- Sharp’s experience with federal projects indicates that at 2.1% savings these systems would not be cost effective
- Energy management control systems typically provide savings exceeding 10% with simple payback between 3 and 10 years

DBEDT CONCLUSIONS

- Study met its objectives
- Study was constrained by limited resources, lack of time, and relied on existing data
- Study methodology is transparent
- Benefits are that the study quantifies energy use by State agency and estimates savings for ECMs
- Buildings will still have to be assessed individually to determine potential
- Study is a useful resource

ACKNOWLEDGEMENTS

- Melik Yalcintas and Joel Yuen, Cedric Chong & Associates
- Carilyn Shon, DBEDT
- Bill Lane, HECO
- Wayne Nakamura, HCDCH
- James Hisano and Dean Shimomura, DAGS-CS
- Wendy Cheuk, Airports-DOT
- Roy Ikeda and Sucuma Elliot, Department of Education
- John Dunbar and Frank Kingery, TetraTech